

Chapter 3

Identifying Hazards and Mitigating Risk

Introduction

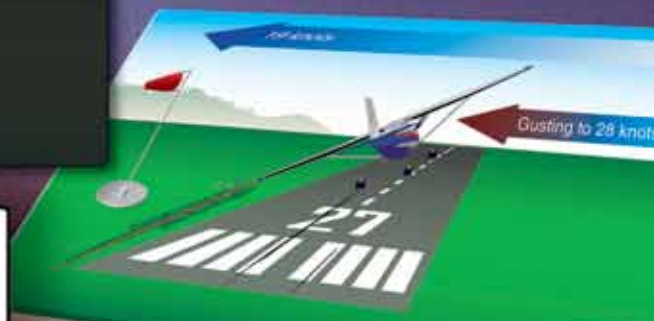
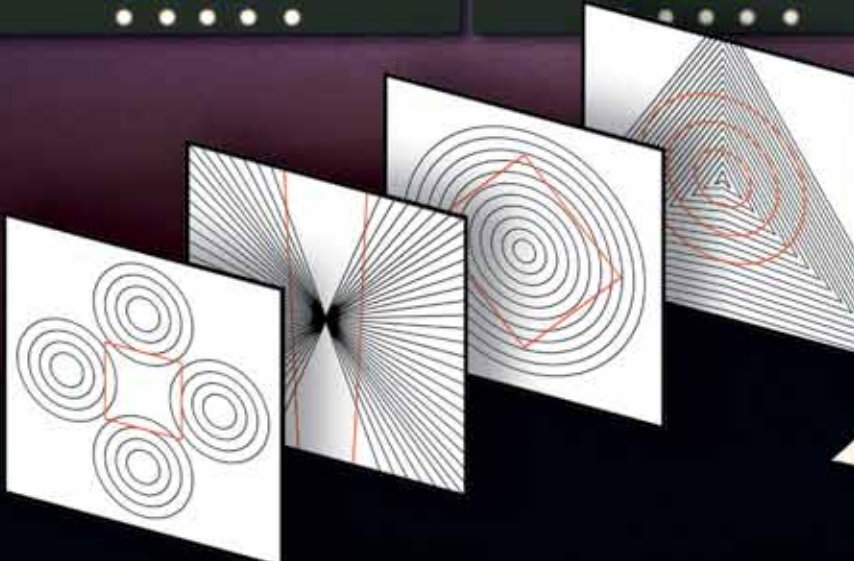
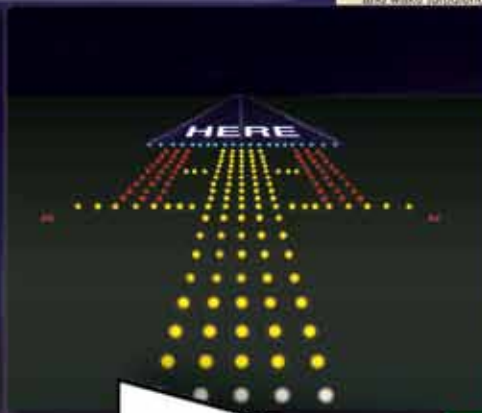
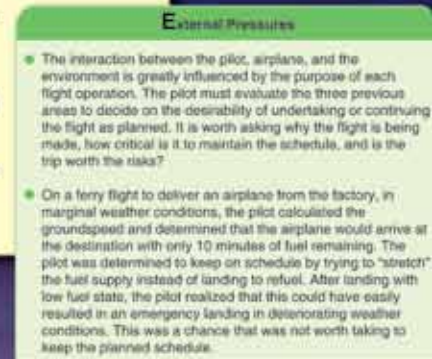
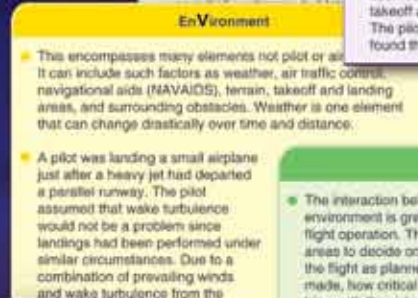
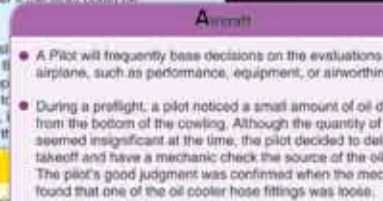
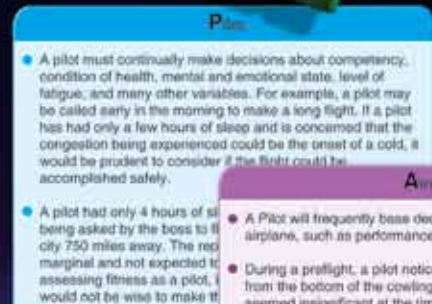
As previously discussed, identifying hazards and associated risk is key to preventing risk and accidents. If a pilot fails to search for risk, it is likely that he or she will neither see it nor appreciate it for what it represents. Unfortunately in aviation, pilots seldom have the opportunity to learn from their small errors in judgment because even small mistakes in aviation are often fatal. In order to identify risk, the use of standard procedures is of great assistance. One guide in the form of a checklist that helps the pilot examine areas of interest in his or her preflight planning is a framework called PAVE. Elements of PAVE are:

Pilot-in-command (PIC)

Aircraft

EnVironment

External pressures



Using PAVE helps to identify risk before departure and assists the pilot's decision-making process. [Figure 3-1]

With the PAVE checklist, pilots have a simple way to remember each category to examine for risk prior to each flight. Once a pilot identifies the risks of a flight, he or she

needs to decide whether the risk or combination of risks can be managed safely and successfully. If not, make the decision to cancel the flight. If the pilot decides to continue with the flight, he or she should develop strategies to mitigate the risks. One way a pilot can control the risks is to set personal minimums for items in each risk category. These are limits

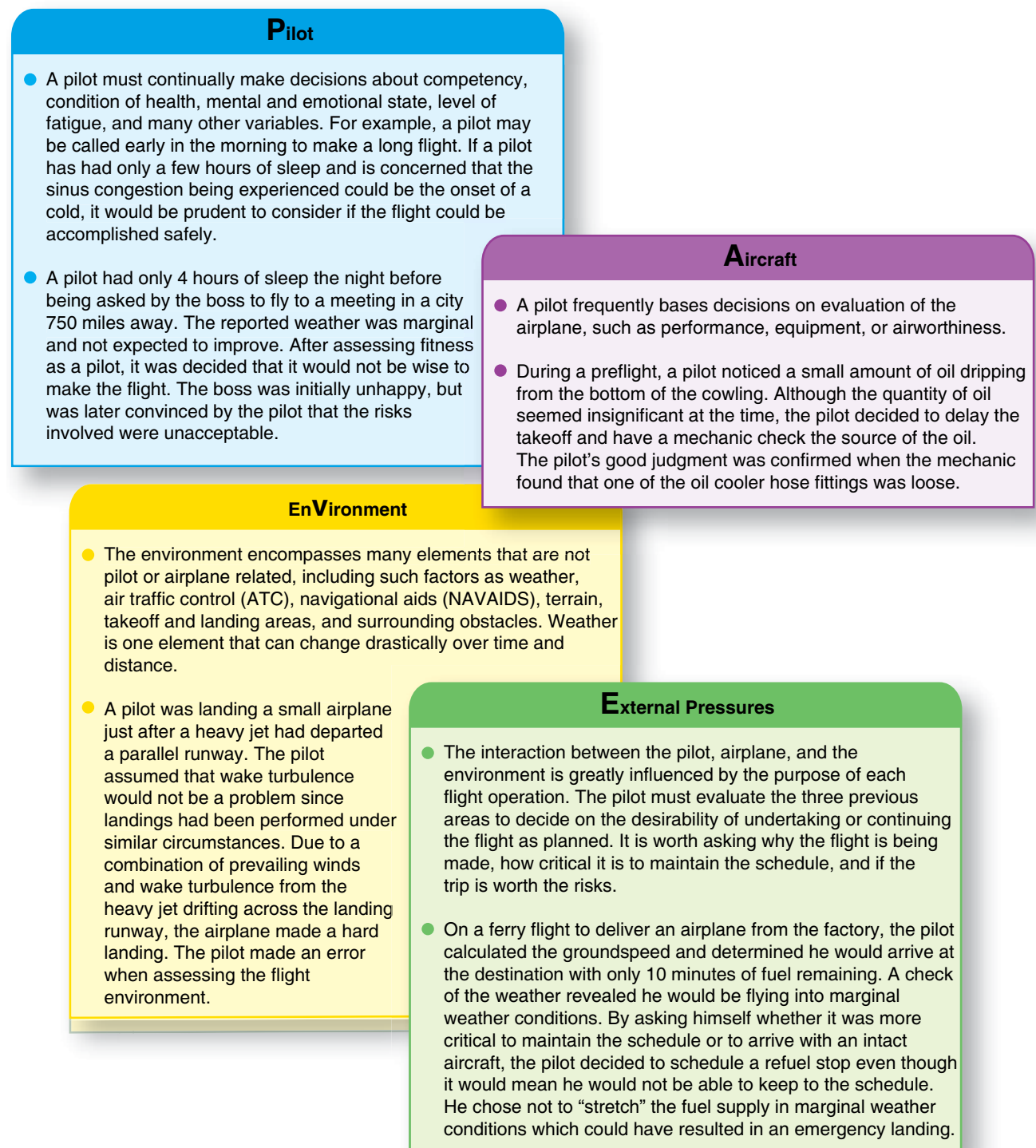


Figure 3-1. The PAVE checklist.

unique to that individual pilot's current level of experience and proficiency.

One of the most important concepts that safe pilots understand is the difference between what is "legal" in terms of the regulations, and what is "smart" or "safe" in terms of pilot experience and proficiency.

P = Pilot in command

The pilot in command (PIC) [Figure 3-2] is one of the risk factors in a flight. The pilot must ask, "Am I ready for this trip?" in terms of experience, currency, physical, and emotional condition.

The Pilot's Health

One of the best ways pilots can mitigate risk is a self-evaluation to ensure they are in good health. A standardized method used in evaluating health employs the IMSAFE checklist. [Figure 3-3] It can easily and effectively be used to determine physical and mental readiness for flying and provides a good overall assessment of the pilot's well being.

1. Illness—Am I sick? Illness is an obvious pilot risk.
2. Medication—Am I taking any medicines that might affect my judgment or make me drowsy?
3. Stress—Am I under psychological pressure from the job? Do I have money, health, or family problems? Stress causes concentration and performance problems.



Figure 3-2. The highest risk for the pilot is self, and requires special introspective analysis.

✓ **I'M SAFE CHECKLIST**

Illness—Do I have any symptoms?

Medication—Have I been taking prescription or over-the-counter drugs?

Stress—Am I under psychological pressure from the job? Worried about financial matters, health problems, or family discord?

Alcohol—Have I been drinking within 8 hours? Within 24 hours?

Fatigue—Am I tired and not adequately rested?

Emotion—Am I emotionally upset?

Figure 3-3. *IMSAFE checklist.*

While the regulations list medical conditions that require grounding, stress is not among them. The pilot should consider the effects of stress on performance.

4. Alcohol—Have I been drinking within 8 hours? Within 24 hours? As little as one ounce of liquor, one bottle of beer, or four ounces of wine can impair flying skills. Alcohol also renders a pilot more susceptible to disorientation and hypoxia.
5. Fatigue—Am I tired and not adequately rested? Fatigue continues to be one of the most insidious hazards to flight safety, as it may not be apparent to a pilot until serious errors are made.
6. Emotion—Have I experienced any emotionally upsetting event?

Stress Management

Everyone is stressed to some degree almost all of the time. A certain amount of stress is good since it keeps a person alert and prevents complacency. Effects of stress are cumulative and, if the pilot does not cope with them in an appropriate way, they can eventually add up to an intolerable burden. Performance generally increases with the onset of stress, peaks, and then begins to fall off rapidly as stress levels exceed a person's ability to cope. The ability to make effective decisions during flight can be impaired by stress. There are two categories of stress—acute and chronic. These are both explained in Chapter 16, Aeromedical Factors, of the Pilot's Handbook of Aeronautical Knowledge. Factors referred to as stressors can affect decision-making skills and increase a pilot's risk of error in the flight deck. [Figure 3-4].

For instance, imagine a cabin door that suddenly opens in flight on a Bonanza climbing through 1,500 feet on a clear sunny day? It may startle the pilot, but the stress would wane when it became apparent that the situation was not a

Stressors
Environmental Conditions associated with the environment, such as temperature and humidity extremes, noise, vibration, and lack of oxygen.
Physiological Stress Physical conditions, such as fatigue, lack of physical fitness, sleep loss, missed meals (leading to low blood sugar levels), and illness.
Psychological Stress Social or emotional factors, such as a death in the family, a divorce, a sick child, or a demotion at work. This type of stress may also be related to mental workload, such as analyzing a problem, navigating an aircraft, or making decisions.

Figure 3-4. *System stressors have a profound impact, especially during periods of high workload.*

serious hazard. Yet, if the cabin door opened in instrument meteorological conditions (IMC), the stress level would be much higher despite little difference between the two scenarios. Therefore, one can conclude that our perception of problems (and the stress they create) is related to the environment in which the problems occur.

Another example is that mechanical problems always seem greater at night, a situation that all pilots have experienced. The key to stress management is to stop, think, and analyze before jumping to a conclusion. There is usually time to think before drawing conclusions.

There are several techniques to help manage the accumulation of life stress, and prevent stress overload. For example, to help reduce stress levels, set aside time for relaxation each day or maintain a program of physical fitness. To prevent stress overload, learn to manage time more effectively to avoid pressures imposed by getting behind schedule and not meeting deadlines.

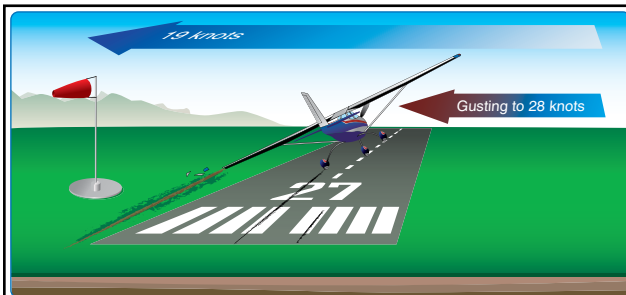
A = Aircraft

What about the aircraft? What limitations will the aircraft impose upon the trip? Ask yourself the following questions:

- Is this the right aircraft for the flight?
- Am I familiar with and current in this aircraft? Aircraft performance figures and the aircraft flight manual (AFM) are based on a new aircraft flown by a professional test pilot, factors to keep in mind while assessing personal and aircraft performance.
- Is this aircraft equipped for the flight? Instruments? Lights? Are the navigation and communication equipment adequate?

- Can this aircraft use the runways available for the trip with an adequate margin of safety under the conditions to be flown? For instance, consider an AFM for an aircraft that indicates a maximum demonstrated crosswind component of 15 knots. What does this mean to a pilot? This is the maximum crosswind that the manufacturer's test pilot demonstrated in the aircraft's certification. [Figure 3-5]
- Can this aircraft carry the planned load?
- Can this aircraft operate with the equipment installed?
- Does this aircraft have sufficient fuel capacity, with reserves, for trip legs planned?
- Is the fuel quantity correct? Did I check? (Remember that most aircraft are manufactured to a standard that requires the fuel indicator be accurate when the fuel quantity is full.)

Using the PAVE checklist would help elevate risks that a pilot may face while preparing and conducting a flight. In the case presented in *Figure 3-5*, the pilot disregarded the risk, failed to properly evaluate its impact upon the mission, or incorrectly perceived the hazard and had an inaccurate perception of his skills and abilities.



At 1030, Cessna 150M veered off the runway and collided with a ditch during a crosswind landing. The private pilot, the sole occupant, sustained minor injuries; the airplane sustained substantial damage. The pilot stated in a written report that he configured the airplane for a straight in approach to runway 27. After touchdown, the airplane veered to the left and departed the runway. The airplane continued through an adjacent field and collided with a ditch. The airplane sustained a buckled firewall and a bent left wing spar. The closest official weather observation was 8 nautical miles (NM) east of the accident site. An aviation routine weather report (METAR) was issued at 0954. It stated: winds from 360 degrees at 19 knots gusting to 28 knots; visibility 10 miles; skies 25,000 feet scattered; temperature 25 °C; dew point 2 °C; altimeter 30.04" Hg.

Figure 3-5. *Considering the crosswind component.*

V = Environment

Weather

Weather is a major environmental consideration. As pilots set their own personal minimums, they should evaluate the weather for a particular flight by considering the following:

- What are the current ceiling and visibility? In mountainous terrain, consider having higher minimums for ceiling and visibility, particularly if the terrain is unfamiliar.
- Consider the possibility that the weather may be different from forecast. Have alternative plans and be ready and willing to divert should an unexpected change occur.
- Consider the winds at the airports being used and the strength of the crosswind component. [Figure 3-5]
- If flying in mountainous terrain, consider whether there are strong winds aloft. Strong winds in mountainous terrain can cause severe turbulence and downdrafts and be very hazardous for aircraft even when there is no other significant weather.
- Are there any thunderstorms present or forecast?
- If there are clouds, is there any icing, current or forecast? What is the temperature-dew point spread and the current temperature at altitude? Can descent be made safely all along the route?
- If icing conditions are encountered, is the pilot experienced at operating the aircraft's deicing or anti-icing equipment? Is this equipment in good condition and functional? For what icing conditions is the aircraft rated, if any?

Terrain

Evaluation of terrain is another important component of analyzing the flight environment.

- To avoid terrain and obstacles, especially at night or in low visibility, determine safe altitudes in advance by using the altitudes shown on visual flight rules (VFR) and instrument flight rules (IFR) charts during preflight planning.
- Use maximum elevation figures (MEF) [Figure 3-6] and other easily obtainable data to minimize chances of an inflight collision with terrain or obstacles.

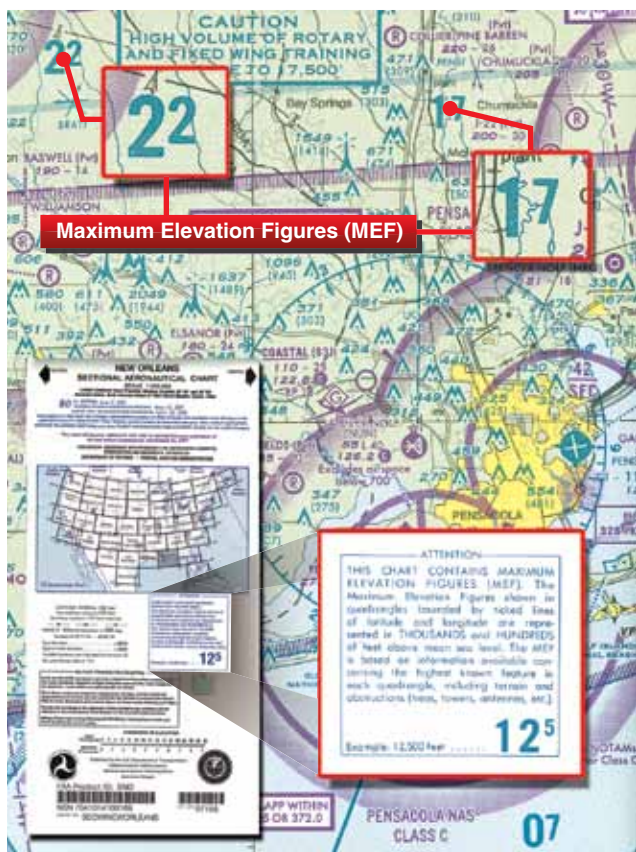


Figure 3-6. The pilot can easily assess elevations at a glance by simply comparing the intended altitude to the minimum elevation figures (MEFs) depicted on all VFR sectional charts. The MEFs are one of the best sources of elevation information and can be used during both the planning and flight phases.

Airport

- What lights are available at the destination and alternate airports (e.g., visual approach slope indicator (VASI), precision approach path indicator (PAPI) or instrument landing system (ILS), glideslope guidance)? [Figure 3-7] Is the terminal airport equipped with them? Are they working? Will the pilot need to use the radio to activate the airport lights?
- Check the Notices to Airmen (NOTAMS) for closed runways or airports. Look for runway or beacon lights out, nearby towers, etc.
- Choose the flight route wisely. An engine failure gives the nearby airports supreme importance.
- Are there shorter or obstructed fields at the destination and/or alternate airports?

Airspace

- If the trip is over remote areas, are appropriate clothing, water, and survival gear onboard in the event of a forced landing?
- If the trip includes flying over water or unpopulated areas with the chance of losing visual reference to the horizon, the pilot must be prepared to fly IFR.
- Check the airspace and any temporary flight restrictions (TFRs) along the route of flight.

Nighttime

Night flying requires special consideration.

- If the trip includes flying at night over water or unpopulated areas with the chance of losing visual

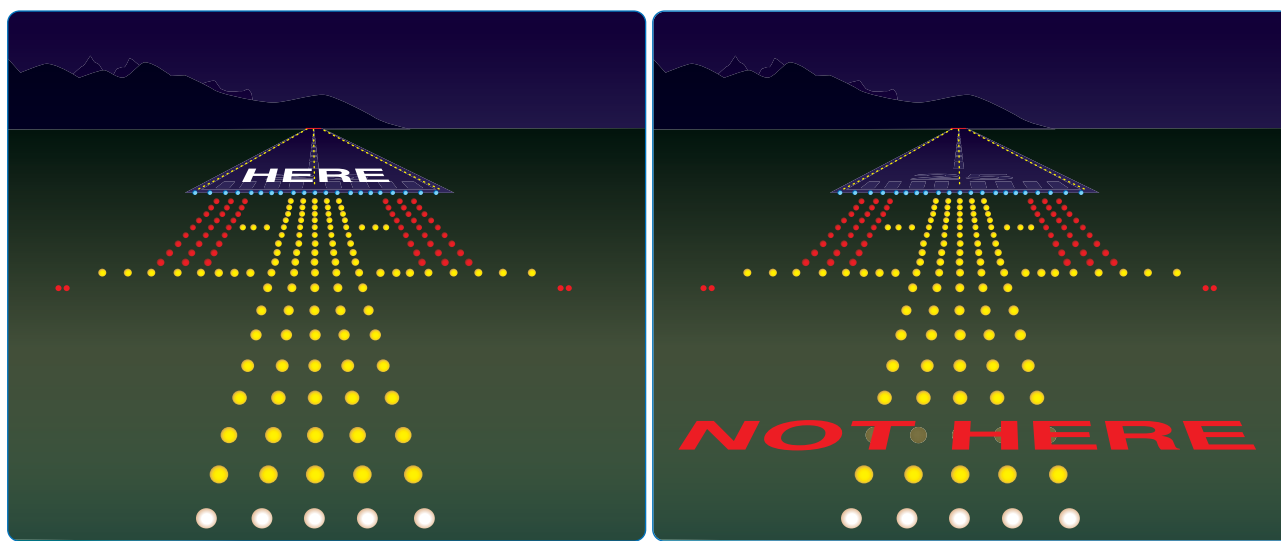


Figure 3-7. Although runways that provide plain-spoken information (as shown above) would require little interpretation, it is important to understand and interpret runway indicators used in the aviation environment.

reference to the horizon, the pilot must be prepared to fly IFR.

- Will the flight conditions allow a safe emergency landing at night?
- Preflight all aircraft lights, interior and exterior, for a night flight. Carry at least two flashlights—one for exterior preflight and a smaller one that can be dimmed and kept nearby. [Figure 3-8]



Figure 3-8. A chemical stick is useful to carry onboard the aircraft at night. It comes in various colors, intensities, and durations, and it provides ample illumination within the flight deck. This does not replace the regulatory requirement of carrying flashlights.



The human eye will see nothing outside that is dimmer than the flight deck lighting. Always fly at night with the interior lights as dim as possible. As the flight progresses and the eyes adjust to the darkness, usually the interior lights can be dimmed further, aiding the outside vision. If the interior lights will not dim, that would increase the risk factors by restricting the pilot's outside vision—probably not the time for a night flight.

Visual Illusions

Although weather, terrain, airport conditions, and night versus daylight flying each produce unique challenges, together these factors conspire against a pilot's senses. It is important to understand that unwittingly these factors can create visual illusions and cause spatial disorientation producing challenges the pilot did not anticipate. [Figure 3-9] Even the best trained pilots sometimes fail to recognize a problem until it is too late to complete a flight safely.

An accident involving a Piper PA-32 and an airline transport pilot illustrates how visual illusions can create problems that lead to an accident. In this case, the aircraft collided with terrain during a landing. The sole occupant of the airplane was an airline transport pilot who was not injured. The airplane owned and operated by the pilot, sustained substantial damage. The personal transportation flight was being operated in visual meteorological conditions (VMC) in mid-afternoon. Although it was not snowing, there was snow on the ground.

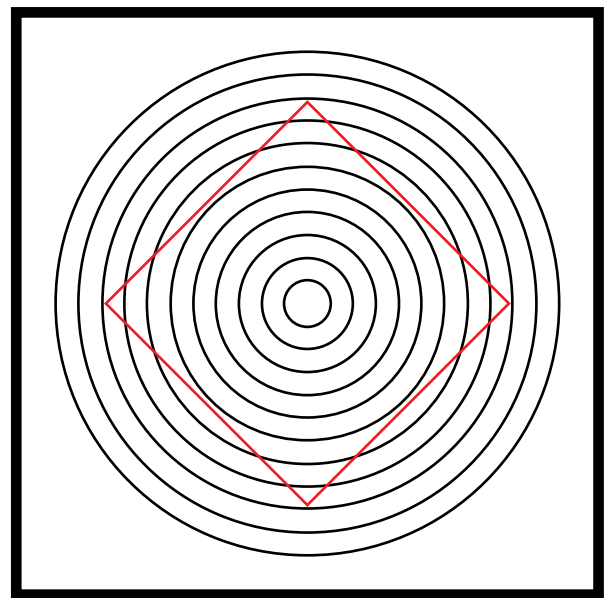


Figure 3-9. Visual illusions are easy to see when shown in the examples above. The illusion on the left represents how the brain processes color. The “brown” square on top and the “orange” square on the side are actually the same color. The illusion on the right appears to have red lines that curve; however, they are straight. These illusions are representative of things we see in everyday life, except we do not see them as they really are until it is sometimes too late. Understanding that visual illusions exist is a prime ingredient to being better prepared to cope with risk.

Originally on an IFR flight plan, the pilot canceled his IFR clearance when he had the airport in sight. According to the pilot, he was familiar with the airport, having landed there repeatedly in the past. However, it had just snowed, leaving a thin layer of snow and mixed ice on the runway. The pilot in this case allowed his familiarity with the airport coupled with his flight experience give him a false sense of confidence. As a result, he failed to realistically assess the potential snow and ice hazard on the runway—an assessment overshadowed by his own self-assurance exacerbated by his familiarity and experience.

On the day of the accident, the runway was covered with one inch of snow and ice. Previously plowed snow lined the runway. Although he had not landed on a snow-covered runway in 10 years, the pilot felt his knowledge of the runway environment and familiarity with the airfield would compensate for this lack of currency in landing in these types of conditions. During the final approach, the visual cues normally available to a pilot were not present. That is, the snow-covered terrain presented problems for the pilot in ascertaining proper depth of field, recognized as a visual illusion. When he landed, his normally available lateral visual cues were obscured by the snow, causing him to come in at a higher altitude than he normally would have. Disoriented by the snow and lacking knowledge on how to adapt properly to these conditions, he was unable to determine his position relative to the runway centerline and landed left of the intended point. By focusing his attention on the snow banks, he drifted further toward the edge of the runway causing one of the airplane's main gears to miss the runway surface.

The risk at hand could be addressed in the following manner. Does landing on snow and ice require any special skills? Do you have these skills? Are you current in using these skills? If landing in ice and snow requires special airmanship skills that transcend normal pilotage and you do not have that skill or you are no longer experienced in this situation, then the risk is increased and you need to recognize that just because you are a pilot does not mean you are proficient at doing all of the maneuvers you are legally qualified to perform. Examine seaplane ratings, mountain training, and tail-wheel proficiency. This proficiency starts to wane the moment a pilot stops performing maneuvers requiring these skills.

Immediately after touching down, the wheel that was off the edge of the runway hit a snow-covered mound of previously plowed snow. The impact threw the airplane sideways and it collided with more of the previously plowed snow. During this sequence, all three landing gear struts collapsed and the underside of the airplane sustained considerable structural damage.

What could this pilot have done to prevent this accident from happening? In addition to maintaining currency in landing on a snow-covered runway, he could have prevented this accident by choosing an alternate airport that had a cleared runway. He could have taken another pilot, junior or senior to his overall experience who has landed in similar conditions recently. Certainly he could have been better prepared. He could have read about landing in these conditions and better prepared himself for landing on snow and ice. He could have planned. Before landing on snow-covered terrain, a pilot needs to understand how to accomplish the landing since the techniques are not the same as those for landing on a clear, dry runway. In this example, the pilot applied the same methods of ascertaining depth perception as normally used if the terrain were not blanketed in snow.

In this case, the basic underlying problem was the pilot's failure to prepare for the conditions. He knew the challenge that faced him, and he had the assets to prepare himself better, yet he did not. In reality, the hazard in this case is not just the snow or the challenges it presented, but the pilot himself in being overly confident and even complacent to his responsibilities. Had this aircraft been carrying passengers and had the accident occurred under slightly different conditions, the end result could have been tragic.

The first and key step in preparing for a new situation is to recognize that one may not have the required skill set—the step of recognizing personal limitations. The next step is acquiring that skill set. A pilot who has never landed on snow, or one whose skills have eroded from lack of recent practice, can do the following to acquire or renew the skill set necessary for a successful landing in snow conditions:

1. Review reference materials to reinforce and increase knowledge about visual illusions and their causes:
 - Aeronautical Information Manual (AIM) Chapter 8, Medical Facts for Pilots
 - Pilot's Handbook of Aeronautical Knowledge, Chapter 15, Navigation
 - Advisory Circular (AC) 60-4, Spatial Disorientation
 - AC 90-48, Pilot's Role in Collision Avoidance
2. Fly with an instructor pilot or other PIC who has had significant experience in landing on snow.
3. Participate in a training designed specifically for landing in unusual places and environments. Many pilots attend classes on mountain flying in which they learn techniques to use in the absence of standard visual cues.

E = External Pressures

External pressures are influences external to the flight that create a sense of pressure to complete a flight—often at the expense of safety. Factors that can be external pressures include the following:

- Someone waiting at the airport for the flight's arrival
- A passenger the pilot does not want to disappoint
- The desire to demonstrate pilot qualifications
- The desire to impress someone (Probably the two most dangerous words in aviation are “Watch this!”)
- Desire to satisfy a specific personal goal (“get-home-itis,” “get-there-itis,” and “let’s-go-itis”)
- A pilot’s general goal-completion orientation
- The emotional pressure associated with acknowledging that skill and experience levels may be lower than a pilot would like them to be. (Pride can be a powerful external factor.)

The following accident offers an example of how external pressures influence a pilot. Two pilots were giving helicopter demonstrations at an air show. The first pilot demonstrated a barrel roll in front of the stands. Not to be outdone, the second pilot (with passengers) decided to execute a hammerhead type maneuver. Flying past the stands at 90 knots, the pilot pulled the helicopter into a steep climb that ended at about 200 feet. When the speed dissipated to near zero, he rolled back to the ground in a nose-low attitude to regain airspeed with the obvious intention of pulling the aircraft out of the dive near the ground. An error in judgment led to the pilot being unable to pull the helicopter out of the dive. The helicopter struck the ground, killing all onboard.

The desire to impress someone can be a powerful external pressure, especially when coupled with the internal pressure of pride. Perhaps the pilot decided to perform a maneuver not in his training profile, or one in which he had not demonstrated proficiency. It appears there was nothing in this pilot’s experiences to help him effectively assess the high risk of this maneuver in an aircraft loaded with passengers. It is not uncommon to see people motivated by external pressures who are also driven internally by their own attitude.

Management of external pressure is the single most important key to risk management because it is the one risk factor category that can cause a pilot to ignore all other risk factors. External pressures place time-related pressure on the pilot and figure into a majority of accidents.

Helicopter Emergency Medical Service (HEMS) operations, unique due to the emergency nature of the mission, are an example of how external pressures influence pilots. Emergency medical services (EMS) pilots often ferry critically ill patients, and the pilot is driven by goal completion. In order to reduce the effect of this pressure, many EMS operators do not to notify the EMS pilot of the prospective patient’s condition, but merely confine the location of the patient pickup and restrict the pilot’s decision-making role to the response to the question “Can the pickup and transportation to the medical care center be made safely?” Risking three or four lives in an attempt to save one life is not a safe practice.

The use of personal standard operating procedures (SOPs) is one way to manage external pressures. The goal is to supply a release for the external pressures of a flight. These procedures include, but are not limited to:

- Allow time on a trip for an extra fuel stop or to make an unexpected landing because of weather.
- Have alternate plans for a late arrival or make backup airline reservations for must-be-there trips.
- For really important trips, plan to leave early enough so that there would still be time to drive to the destination.
- Advise those who are waiting at the destination that the arrival may be delayed. Know how to notify them when delays are encountered.
- Manage passenger expectations. Ensure passengers know that they might not arrive on a firm schedule, and if they must arrive by a certain time, they should make alternative plans.
- Eliminate pressure to return home, even on a casual day flight, by carrying a small overnight kit containing prescriptions, contact lens solutions, toiletries, or other necessities on every flight.

The key to managing external pressure is to be ready for and accept delays. Remember that people get delayed when traveling on airlines, driving a car, or taking a bus. The pilot’s goal is to manage risk, not increase it.

Chapter Summary

Risk can be identified and mitigated by using checklists such as PAVE and IMSAFE. Accident data offers the opportunity to explain how pilots can use risk management to increase the safety of a flight.

